IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

CYWEE GROUP LTD.,	§	
Plaintiff	§	
	§	
v.	§	NO. 2:17-CV-00140-RWS-RSP
	§	
SAMSUNG ELECTRONICS CO. LTD. AND SAMSUNG ELECTRONICS AMERICA, INC.,	§	
	§	
Defendants.	§	

RESPONSIVE DECLARATION OF M. RAY MERCER, PH.D.

I. INTRODUCTION

I, M. Ray Mercer, Ph.D. hereby declare as follows:

1. My name is Melvin Ray Mercer. I am at least eighteen years of age. I reside in Dallas in the State of Texas. I have personal knowledge of and am competent to testify as to the facts and opinions herein.

2. I have been retained by counsel for Defendants Samsung Electronics Corporation Ltd. and Samsung Electronics America, Inc. (collectively "Samsung") as an expert to analyze and explain what certain claim terms in U.S. Patent Nos. 8,441,438 ("'438 Patent") and 8,552,978 ("'978 Patent") (collectively, "patents-in-suit") would mean to a person of ordinary skill in the art ("POSA") at the time of the alleged inventions.

3. I have been informed that CyWee Group Ltd. ("CyWee") is currently asserting certain claims of the '438 and '978 Patents against Samsung in a litigation pending in the United States District Court for the Eastern District of Texas.

4. I am being compensated at my normal consulting rate of $650 per hour. I am being separately reimbursed for any out-of-pocket expenses. My compensation does not depend in any way on the outcome of this case, my particular testimony, or the opinions that I express.

5. In rendering my opinions, I considered the items listed in Exhibit A, the items discussed or listed herein, as well as my own experiences in the field.

II. QUALIFICATIONS

6. In this section of my declaration, I provide a brief summary of my qualifications to act as an expert in this matter. A copy of my current Curriculum Vitae was provided in Exhibit B of my January 26th, 2018 Declaration. It contains a listing of my education and experience. It is reattached to this declaration.

7. I have more than 47 years of dual industrial and academic experience in Electrical Engineering and Computer Engineering. I received a B.S. in Electrical Engineering from Texas Tech University in 1968, a Master of Science in Electrical Engineering from Stanford University in 1971, and a Doctor of Philosophy in Electrical Engineering from The University of Texas at Austin in 1980. Further, I have authored dozens of published technical papers and delivered many lectures addressing various aspects of Electrical and Computer Engineering.

8. From 1968 to 1973, I was a Research/Development Engineer at General Telephone and Electronics Sylvania in Mountain View, California. I completed my M.S. in Electrical Engineering from Stanford University in 1971. At Stanford, I worked on techniques that were unique in that they involved adaptive linear optimizations for monitoring non-stationary signals. This work involved the application of filtering and estimation techniques using data gathered from sensors. For example, I worked on a project involving in vitro detection of signals generated by a fetal heartbeat in the presence of multiple noise sources from the pregnant mother. During this period, much of my work related to communications, computer control of data collection, and

analysis systems used by organizations in the United States government. Leading-edge sensing techniques were a key aspect of much of this work.

9. From 1973 to 1977, I was a Member of Technical Staff at Hewlett-Packard's Santa Clara Division and subsequently at Hewlett-Packard Laboratories in Palo Alto, California. During that time, I continued to develop application programs. I also designed interface hardware to interact with computer software and accomplish various tasks. One major project I was responsible for was the real-time control of environmental test systems for satellites and satellite components. Applications for these analysis and control tools required filtering of noise components to isolate data collected by sensors from noise inherent in the system using a previously unknown set of filtering techniques designed and implemented by my team and utilized Fourier Transforms for tasks best performed in the frequency domain. For example, these tools allowed automated analysis of communication systems. Key concepts in this work are related to this case because they involved digital data communications, motion control, motion analysis, and data collection based upon sensors including accelerometers. During this period, I also used variations of these tools to monitor and analyze motions of rigid and semi-rigid objects—particularly with respect to vibration mode analysis. The same tools also found application in the automated diagnosis of communication systems such as telephone systems.

10. At HP Laboratories, among other projects, I developed hardware and software to provide real-time control of manufacturing systems for solid state devices. This work related directly to the issues in this case because the tools I developed involved sensor systems and control systems for displacement, rotation, temperature control, etc. I also did some of the earliest research on the dominant sources for the degradation of liquid crystal displays.

11. From 1977 to 1980, I was a Lecturer in the Division of Mathematics, Statistics, and Computer Science at the University of Texas at San Antonio. As the director of a laboratory for

teaching students to program and build hardware interfaces and control systems using small computers, my students and I purchased, built, and operated some of the earliest personal computers. Additionally, I taught courses in the design of digital systems. During this period, I also completed my Ph.D. in Electrical Engineering at the University of Texas at Austin in 1980. I also did my first consulting work at this time involving the control, sensing, and evaluation of human motion control capabilities under adverse environmental conditions.

12. From 1980 to 1983, I was a Member of Technical Staff at Bell Laboratories in Murray Hill, New Jersey. My work involved the programming of computers and the design of hardware components for communication systems. I was part of a three-person team that designed, tested, and directed the manufacture of an integrated circuit that was a key component in a digital telephone modem. I also actively worked with designers of large scale digital telephone switching systems. This work relates generally to the topics in this case because modems obviously sense and produce sound. The manufacture testing of this product involved extensive investigation of the external sensing aspects of this product and associated conclusions about aspects of the device that were only indirectly determinable.

13. In 1983, I was appointed Assistant Professor of Electrical and Computer Engineering at the University of Texas at Austin. In 1987, I was promoted to Associate Professor and Professor in 1991. During this period, I taught Computer Engineering courses at the undergraduate and graduate level, directed the research of graduate students, and consulted with numerous organizations. One consulting project I did at this time involved the study of early printed circuit board surface mount techniques where component placement was automated using pick-and-robotic systems. As part of this work I interfaced with more than a dozen of the largest printed circuit manufacturers in the United States at that time. Aspects of this work relate to issues in this case since the manufacturing systems made extensive use of sensors and controllers.

14. In 1995, I was appointed Professor of Electrical and Computer Engineering, Leader of the Computer Engineering Group, and Holder of the Computer Engineering Chair in Electrical Engineering at Texas A&M University in College Station, Texas. My teaching, my research, my technical publications, and my supervision of graduate students during that period included the areas of the modeling, design, and fabrication of digital hardware and software systems. As with my previous work (at The University of Texas at Austin), during this period, I taught courses at the undergraduate and graduate level, directed the research of graduate students, and consulted with numerous organizations on a variety of topics. I was also responsible for monitoring controlled experiments to optimize and quantify the use of tester time to detect defects in electrical products, and I was part of a team that used analytical techniques to predict the expected growth of quiescent currents in MOS transistors as a function of the reduction in integrated circuit feature sizes.

15. In September 2005, I retired from my teaching position, and the Regents of the Texas A&M University System appointed me as Professor Emeritus of Electrical and Computer Engineering at Texas A&M University.

16. In 1984, I formed Mercer and Associates, an independent consulting firm that I have owned and directed to this day. Since 1979, I have provided private consultation and advice in Electrical and Computer Engineering to numerous entities, including IBM Corp., Rockwell International, Motorola Semiconductor, AT&T, Inc., and SigmaTel.

17. I first served as an expert witness at the request of the Office of the State Attorney General of Texas in 1984. Since then, I have been hired by numerous law firms to provide them and their clients with expert consultation and expert testimony, often in the areas of patent infringement litigation related to electrical and computer engineering. Among other topics, I have opined with respect to communications systems including telephony, cell phone networks and devices, and particular characteristics of private and public network communications networks, including the

Internet. I have testified regarding standalone and Internet-based online gaming systems. I have testified regarding home entertainment systems that use wireless communications. I have testified with respect to online educational institutions and technical aspects of their media distribution systems. I have testified with respect to media and entertainment systems for mobile vehicles as well as special aspects of display equipment similar to the equipment at issue in the current case. I have testified in a case involving delta-sigma modulation for high performance analog-to-digital and digital-to-analog converters—such as those commonly utilized in personal computers. Many of the technical issues and topics in this work relate directly to the key technical issues in this current case.

18. Throughout my career, I have been actively involved in numerous professional organizations, including the Institute of Electrical and Electronics Engineers ("IEEE") and was recognized as an IEEE Fellow in 1994. I was the Program Chairman for the 1989 International Test Conference, which is an IEEE sponsored annual conference with (at that time) more than one thousand attendees and over one hundred presented papers. I won the Best Paper Award at the 1982 International Test Conference.

19. I also won a Best Paper Award at the 1991 Design Automation Conference, an annual conference with (at that time) more than ten thousand attendees and five hundred submitted papers, many of which related to the design of integrated circuit-based systems.

20. I also won a Best Paper Award at the 1999 VLSI Test Symposium. This paper was focused on manufacturing techniques to optimize the quality of manufactured digital systems. I am the inventor of two United States patents that relate to the design of integrated circuits and digital systems. I was selected as a National Science Foundation Presidential Young Investigator in 1986. This award included $500,000 for support of my research.

III. LEGAL STANDARD

21. I am not an attorney. I have been informed on the law regarding claim construction and patent claims, and my understanding is as follows.

22. I understand that a patent may include two types of claims, independent claims and dependent claims. An independent claim stands alone and includes only the limitations it recites. A dependent claim can depend from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to all of the limitations recited in the claim or claims from which it depends.

23. I understand that the claims of a patent are presumed to be valid, and that, in the venue for this case, invalidity of a claim must be proven by clear and convincing evidence.

24. I am informed that claim construction is a matter of law for the Court to decide. Claim terms should be given their ordinary and customary meaning within the context of the patent in which the terms are used, *i.e.*, the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention in light of what the patent teaches.

25. I am informed that to determine how a POSA would understand a claim term, one should look to those sources available that show what a POSA would have understood disputed claim language to mean. Such sources include the words of the claims themselves, the remainder of the patent's specification, the prosecution history of the patent and the cited references (all considered "intrinsic" evidence), and "extrinsic" evidence, such as dictionary definitions and learned treatises and the opinions of qualified experts concerning relevant scientific principles, the meaning of technical terms, and the state of the art.

26. I understand that, in construing a claim term, one looks primarily to the intrinsic patent evidence, including the words of the claims themselves, the remainder of the patent specification, and the prosecution history.

27. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient.

28. I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else. In making this determination, the claims, the patent specification, and the prosecution history are of paramount importance. Additionally, the specification and prosecution history must be consulted to confirm whether the patentee has acted as its own lexicographer (*i.e.*, provided its own special meaning to any disputed terms), or intentionally disclaimed, disavowed, or surrendered any claim scope.

29. I understand that the claims of a patent define the scope of the rights conferred by the patent. The claims must particularly point out and distinctly claim the subject matter which the patentee regards as his invention. Because the patentee is required to define precisely what he claims his invention to be, it is improper to construe claims in a manner different from the plain meaning of the terms used consistent with the specification. Accordingly, a claim construction analysis must center on the claim language itself. Additionally, the context in which a term is used in the asserted claim can be highly instructive. Likewise, other claims of the patent in question, both asserted and unasserted, can inform the meaning of a claim term. For example, because claim terms are normally used consistently throughout the patent, the usage of a term in one claim can often illuminate the meaning of the same term in other claims. Differences among claims can also be a useful guide in understanding the meaning of particular claim terms.

30. I understand that a POSA is deemed to read a claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. For this reason, the words of the claim must be interpreted in view of the entire specification. The specification is the primary basis for construing the claims and provides

a safeguard such that correct constructions closely align with the specification. Ultimately, the interpretation to be given a term can only be determined and confirmed with a full understanding of what the inventors actually invented and intended to envelop with the claim as set forth in the patent itself.

31. I understand that it is improper to place too much emphasis on the ordinary meaning of the claim term without adequate grounding of that term within the context of the specification of the asserted patent. Hence, claim terms should not be broadly construed to encompass subject matter that, although technically within the broadest reading of the term, is not supported when the claims are read in light of the invention described in the specification. Prior art incorporated by reference or otherwise cited during the prosecution history is also highly relevant in ascertaining the breadth of claim terms and is considered intrinsic evidence.

32. I understand that the role of the specification is to describe and enable the invention. In turn, the claims cannot be of broader scope than the invention that is set forth in the specification. Care must be taken because word-by-word definition, removed from the context of the patent, leads to an overall result that departs significantly from the patented invention.

33. I understand that claim terms must be construed in a manner consistent with the context of the intrinsic record. In addition to consulting the specification, one should also consider the patent's prosecution history, if available. The file history provides evidence of how both the Patent Office and the inventors understood the terms of the patent, particularly in light of what was known in the prior art. Further, where the specification describes a claim term broadly, arguments and amendments made during prosecution may require a more narrow interpretation.

34. I understand that while intrinsic evidence is of primary importance, extrinsic evidence, *e.g.*, all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical

dictionaries may help one better understand the underlying technology and the way in which one of skill in the art might use the claim terms. Extrinsic evidence should not be considered, however, divorced from the context of the intrinsic evidence. Evidence beyond the patent specification, prosecution history, and other claims in the patent should not be relied upon unless the claim language is ambiguous in light of these intrinsic sources. Furthermore, while extrinsic evidence can shed useful light on the relevant art, it is less significant than the intrinsic record in determining the legally operative meaning of claim language.

35. I understand that a claim limitation is indefinite if the claim, when read in light of the specification and the prosecution history, fails to inform with reasonable certainty persons of ordinary skill in the art about the scope of the invention.

36. I am informed that the specification of a patent must satisfy a definiteness requirement, which requires that it conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as the invention.

37. I am also informed that definiteness requires that a patent's claims, viewed in light of the specification and file history from the perspective of a person skilled in the relevant art at the time the patent was filed, inform those skilled in the art about the scope of the invention with reasonable certainty.

38. I understand that a patent must be precise enough to afford clear notice of what is claimed and apprise the public of what subject matter is still open to them in a manner that avoids a zone of uncertainty.

IV. OPINIONS ON UNDERSTANDING OF ONE OF ORDINARY SKILL AND SELECTED CLAIM TERMS

A. Level of Ordinary Skill in the Art

39. I have been asked to provide an opinion as to a person of ordinary skill in the art at the time of the purported invention of the '438 and '978 Patents, which I have been asked to initially

assume is January 6, 2010, the filing date of Provisional Application No. 61/292,558. My opinions below would not change if the time of the invention was July 29, 2009, September 25, 2009, November 11, 2010, March 28, 2011, or July 6, 2011.

40. It is my opinion that one of ordinary skill in the art relevant to the technology of the '438 and '978 Patents is someone who has a computer science, electrical engineering, mechanical engineering, or other related technical degree at the undergraduate level, and knowledge of sensor systems. Superior experience in one of these areas could compensate for lesser experience in the other.

41. I understand that CyWee has asserted that a POSA typically would have had at least a Bachelor's Degree in Computer Science, Electrical Engineering, Mechanical Engineering, or Physics, or equivalent work experience, along with knowledge of sensors (such as accelerometers, gyroscopes, and magnetometers), and mobile computing technologies. My opinions below would not substantively change if the level of a person of ordinary skill in the art were based on CyWee's assertion of a POSA, although I reserve my right to consider and respond to any other opinions or findings as to such a level.

B. Summary of Opinions

42. In summary, it is my opinion that the following claim terms and phrases, read in light of the specification and the prosecution history of the respective patent, fail to inform, with reasonable certainty, those skilled in the art about the scope of the claim in which the terms or phrases appear:

- "utilizing a comparison to compare the first signal set with the second signal set" ('438 Patent, claim 1)
- "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations

Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T" ('438 Patent, claims 14 and 19)

- "generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set" ('978 Patent, claim 10)

43. My detailed opinions are set forth below.

C. The Physical Frame of Reference for the Asserted Claims

44. Neither of the patents-in-suit specifically describes the physical frame of reference for their purported inventions. Therefore, a POSA would have assumed an inertial frame of reference where a given object could experience at least one or more of the following three accelerations:

- Gravitational acceleration due to the gravity of the Earth;
- Linear acceleration due to an external applied force; and
- Centrifugal acceleration due to an external applied force.

45. The patents-in-suit also do not discuss limitations of the domains of application for the purported inventions they claim. For example, it is not clear if the motions of interest are restricted to rigid bodies or if the domains of the applications are broader.

46. A rigid body is an idealized model of a solid object in which any changes in the shape or size of an object are assumed to be zero. In this way, the distance between any two given points between the object remain constant in time regardless of external forces, *i.e.*, the body does not deform as it moves.

47. In non-rigid bodies, external forces may change the shape and/or size of the body as it moves. Without guidance, a POSA would assume the domain of the patents-in-suit to be unrestricted so that it applies to both rigid and non-rigid bodies.

Types of Acceleration

48. Gravitational acceleration measures the acceleration of an object caused by gravitational force.

49. For example, when two spheres of different weight fall from the same height, both are accelerated by gravity at the same rate and hit the ground at the same time.

50. Similarly, when a person steps onto a bathroom scale, the acceleration of gravity deforms a structure similar to a spring, and the amount of the deformation is read as the person's weight.

51. Although the magnitude of acceleration due to gravity is almost constant everywhere on the Earth's surface, its direction with respect to an object's frame of reference changes depending on the object's orientation, because gravitational acceleration is always directed towards the center of the Earth.

52. Linear acceleration measures the rate of change of linear velocity with respect to time. Linear velocity is the rate of change of the position of an object traveling along a straight path.

53. Humans may produce simple linear acceleration. For example, when a person throws a dart toward a bull's eye, his arm attempts to linearly accelerate the dart from an initial velocity of zero to the correct velocity so that, after its release, the trajectory of the dart terminates within the bull's eye.

54. Machines can also produce simple linear acceleration. A gun linearly accelerates a bullet from an initial velocity (normally zero) to the very high velocity at which it leaves the gun barrel.

55. Centrifugal acceleration results when a rotating body (such as a weight held by a string) rotates about a point (such as the center of the circle of motion).

56. Rotational motion may be simple or compound. For example, rotational motion induced by a single rigid body motion is simple because the radius of rotation remains constant. Rotational motion induced by multiple rigid bodies or non-rigid bodies may produce more complex motions.

57. Centrifugal accelerations can be either simple or compound (if the motions are not induced by a single rigid object.).

58. As one example, the centrifugal force experienced by a baseball when it is thrown by a mechanical pitching machine is simple because there is a fixed radius of rotation and a fixed center of rotation. In the case of this motion, both of these values are constant.

59. In contrast, when the ball is thrown by a human, the centrifugal force experienced by the baseball is compound. This is because the angle of the pitcher's arm at his elbow changes during the pitch, and therefore, the radius of curvature changes when the pitcher moves. Further, the pitcher's shoulder and wrist also move so that many complex motions are combined—and each of these anatomical parts induces different radial motions, each with a different radius that may be a constant or variable value.

D. <u>"utilizing a comparison to compare the first signal set with the second signal set" ('438 Patent, claim 1)</u>

60. This element appears in claim 1 of the '438 Patent and its dependents.

61. Claim 1 of the '438 Patent recites (emphasis added):

> 1. A three-dimensional (3D) pointing device subject to movements and rotations in dynamic environments, comprising:
>
> a housing associated with said movements and rotations of the 3D pointing device in a spatial pointer reference frame;
>
> a printed circuit board (PCB) enclosed by the housing;
>
> a six-axis motion sensor module attached to the PCB, comprising a rotation sensor for detecting and generating a first signal set comprising angular velocities ωx, ωy, ωz associated with said

> movements and rotations of the 3D pointing device in the spatial pointer reference frame, an accelerometer for detecting and generating a second signal set comprising axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame; and
>
> a processing and transmitting module, comprising a data transmitting unit electrically connected to the six-axis motion sensor module for transmitting said first and second signal sets thereof and a computing processor for receiving and calculating said first and second signal sets from the data transmitting unit, communicating with the six-axis motion sensor module to calculate a resulting deviation comprising resultant angles in said spatial pointer reference frame by **utilizing a comparison to compare the first signal set with the second signal set** whereby said resultant angles in the spatial pointer reference frame of the resulting deviation of the six-axis motion sensor module of the 3D pointing device are obtained under said dynamic environments, wherein the comparison utilized by the processing and transmitting module further comprises an update program to obtain an updated state based on a previous state associated with said first signal set and a measured state associated with said second signal set; wherein the measured state includes a measurement of said second signal set and a predicted measurement obtained based on the first signal set without using any derivatives of the first signal set.

62. As set forth above, claim 1 recites "utilizing a comparison to compare the first signal set with the second signal set." I have considered the meaning of this claim element in the context of the '438 Patent.

63. Claim 1 further recites that the "first signal set" comprises "angular velocities ωx, ωy, ωz associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame." Claim 1 recites that this first signal set is detected and generated by a rotation sensor.

64. Claim 1 recites that the "second signal set" comprises "axial accelerations Ax, Ay, Az associated with said movements and rotations of the 3D pointing device in the spatial pointer reference frame." Claim 1 recites that this second signal set is detected and generated by an accelerometer.

65. In my opinion, a POSA would not have understood the meaning of this element with reasonable certainty for at least three reasons.

66. First, a POSA would have understood that the term "axial accelerations" could have multiple possible interpretations. Specifically, an "axial acceleration" could connote the combination of one or multiple possible acceleration components resulting from: (i) the force of gravity; (ii) external forces that impose linear accelerations; and (iii) centrifugal forces producing non-straight line motion that impose one or more centrifugal accelerations (since the structures imposing the centrifugal accelerations are not necessarily a single rigid body).

67. Second, a POSA would have understood that it would be impossible to correctly decompose a given reading from an accelerometer in order to determine the individual values of each of the components of acceleration induced by the forces identified above.

68. Third, a POSA would have understood that under any of the practical interpretations of axial accelerations, it would be mathematically impossible to compare the angular velocities with the axial accelerations. Even if CyWee claims that "axial accelerations" can be compared to centrifugal accelerations, the '438 Patent does not describe how to determine even a single radius of curvature of the motion of the 3D pointing device. Therefore, no such comparison is taught.

69. I address each of these reasons in detail below.

<u>"Axial Acceleration" Ambiguities</u>

70. A POSA would have understood that the term "axial accelerations" could have multiple possible interpretations.

71. As disclosed above, claim 1 of the '438 Patent recites that "axial accelerations" are detected and generated as a "second signal set" by an accelerometer.

72. In general, an accelerometer reports three different types of acceleration: (i) linear acceleration; (ii) centrifugal acceleration; and (iii) gravitational acceleration (described above in ¶¶

48–59).

73. The '438 Patent does not disclose whether the "axial accelerations" are: (i) linear accelerations; (ii) centrifugal accelerations; (iii) gravitational accelerations; or (iv) one of several possible combinations of these three.

74. Therefore, a POSA would not know with reasonable certainty the scope of claim 1.

<u>Inseparability of Components of the Underlying Accelerations</u>

75. If the "axial accelerations" are interpreted as the sum of the three accelerations described above (which is the case generally), it would have been unclear to a POSA how to obtain the value(s) of one or more of the individual component accelerations.

76. Acceleration readings from an accelerometer do not indicate the source(s) or type(s) of the component accelerations. Thus, a POSA would have understood that an accelerometer cannot distinguish between these different types of acceleration. Instead, they are all inseparably combined together.

77. The '438 Patent does not disclose, and a POSA would not have known, how to decompose the combined accelerometer reading to obtain any one of the three types of component accelerations.

78. Because measured acceleration components are combined to produce the output from an accelerometer, the only method to obtain values for an individual acceleration component is to place the object in a controlled environment that ensures that only one type of acceleration is being measured at some given time. Under such restricted conditions, individual acceleration components may remain constant over time, but the specifications of the patents-in-suit neither teach nor contemplate this restricted situation.

79. The '978 Patent specification indirectly refers to this problem when it discloses "undesirable" external forces that result in "undesirable axial accelerations" when trying to obtain an

"updated state." It notes that these "undesirable axial accelerations" should be "preferably excluded." *See* '978 Patent, cols. 9:44–55, 24:34–43. But both specifications fail to provide an approach by which this can be accomplished.

80. Further, if the rotational movement of the 3D pointing device is compound (*e.g.*, not being moved by single rigid object), determining the component centrifugal accelerations requires complete information with respect to all the different rotational motions over the entire time interval, with all their potentially different radial motions (each with a potentially different radius of motion.).

81. The '438 Patent never discusses how to decompose such compound accelerations.

<u>The Mathematical Comparison of Acceleration Components with Angular Velocities Is Generally Impossible</u>

82. A POSA would have understood that under any of the practical interpretations of axial accelerations, claim 1 of the '438 Patent requires performing a mathematically impossible calculation.

83. Specifically, claim 1 recites "utilizing a comparison" in order to "compare" the "axial accelerations" with "angular velocities."

84. As discussed above, claim 1 of the '438 Patent recites that "angular velocities" are detected and generated as a "first signal set" by a rotation sensor.

85. The angular velocity of a moving object measures the time rate of change of the angular position of a rotating body, usually expressed in radians per second.

86. Neither the measured information from a rotation sensor nor information from an accelerometer includes the instantaneous radius of rotation.

87. Further, angular rotations may also be compound such that they are the sum of a number of rotations, each with a potentially different radius of rotation around different centers of rotation (which may also be moving).

88. For example, the anatomical parts of a pitcher's arm (forearm, upper arm, hand, wrist, and shoulder) can simultaneously rotate at different angular velocities around different (and potentially moving) centers of rotation resulting in a complex motion for the ball in the pitcher's hand before it is released.

89. The '438 Patent specification does not disclose a method for dealing with such compound rotational (potentially in combination with translational) motion.

90. If the axial acceleration is interpreted as being based upon an object's linear acceleration, it is mathematically impossible to compare that object's linear acceleration with an equivalent angular velocity.

91. If at least part of the object's axial acceleration is interpreted as being based upon gravitational acceleration, it is also mathematically impossible to compare the object's gravitational acceleration with its angular velocity.

92. This is because generally each of: (i) the angular velocity of an object; (ii) the linear acceleration of that same object; and (iii) gravitational accelerations experienced by that object are all mutually independent. In other words, an object's linear and gravitational accelerations do not affect its angular velocity.

93. For example, an accelerometer and gyroscope could be mounted on a ball. If the ball is spun on a string around a center of rotation by a person who is riding on a train in linear motion that is on a non-spherical section of the Earth's surface, there are three independent component accelerations that are combined to produce one value expressed by the accelerometer mounted on the ball. The measurement of the angular velocity of the ball, however, provides no information on the component values of linear acceleration (movement on train) or gravitational acceleration (gravitational force based on position in non-spherical section of the Earth's surface), or vice versa.

94. Under the third interpretation, if the axial acceleration is interpreted as an object's centrifugal acceleration, without additional information, it is still impossible to compare the object's centrifugal acceleration with its angular velocity.

95. Although the magnitude of the centrifugal acceleration is related to the object's angular velocity, the centrifugal acceleration also depends on the radius of curvature of the motion's curved path.

96. Thus, even in the simplest case of circular rotation, in order to relate an instantaneous centrifugal force to a corresponding instantaneous angular velocity, the instantaneous radius of rotation must be known. The specifications of the patents-in-suit never discuss this problem or propose a solution for it.

97. The '438 Patent neither considers nor discusses the radius of rotation associated with a centrifugal acceleration, how to determine it, or how to use it in relating angular motion to measured centrifugal acceleration.

98. Further, except for rotation induced by a single rigid body, this curvature in general is variable and the rotational motions may be compound—each with a different radius of curvature. For example, as a pitcher delivers a pitch, the change of the angle between his forearm and upper arm (as allowed by his elbow) changes the radius of rotation of the ball being thrown. A second additional rotational motion (and the associated accelerations) will be imparted by the wrist.

99. The '438 Patent neither considers nor discusses how to deal with such compound rotational movements.

100. Accordingly, a POSA would not have been able to determine the centrifugal acceleration of a device in rotational motion based upon the disclosure in the '438 Patent.

101. These problems similarly apply if the axial accelerations are interpreted as some combination of linear, centrifugal, and/or gravitational accelerations.

Response to January 12, 2018 Declaration of Joseph J. LaViola, Jr.

102. I understand that CyWee alleges that the limitation "utilizing a comparison to compare the first signal set with the second signal set" does not require construction.

103. I understand that CyWee alleges in the alternative that if the term is construed, it should be construed as: "determining or assessing differences based on a previous state associated with the first signal set and a measured state associated with the second signal set while calculating deviation angles."

104. I understand that in his declaration in support of CyWee's proposed construction, Dr. LaViola contends that "comparing" as used in claim 1 of the '438 Patent generally refers to "determining or assessing differences" between two values. In this way Dr. LaViola contends, even if two values cannot be "directly compared" because they are in different units or have different physical quantities, the "values can often be mapped or transformed to a common state/units/space before comparison." LaViola January 28, 2018 Decl., ¶ 18. As an example, Dr. LaViola argues that monetary amounts in different currencies can be converted before being compared. *Id.*

105. Dr. LaViola argues that because angular velocities and axial accelerations have different quantities, a direct comparison between them is not recited in claim 1. *Id.*, ¶ 21. Instead, Dr. LaViola simply cites the contention in the '438 Patent that the claimed comparison is accomplished "by comparing signals of rotation sensor related to angular velocities or rates with the ones of accelerometer related to axial accelerations." *Id.*, ¶ 20. This disclosure lacks specific details of how the comparison is calculated. Dr. LaViola also cites Figures 7 and 8 of both the '438 and '978 Patents, but these figures are similarly vague. *Id.*, ¶¶ 21–22.

106. Rather than pointing to anything in the patent that provides details on this comparison, Dr. LaViola instead just states vaguely that the angular accelerations and axial accelerations are first converted to a common state prior to being compared. *Id.*, ¶¶ 21–22.

107. Dr. LaViola's analysis misses the point for several reasons.

108. First, Dr. LaViola cannot and does not point to any guidance in the '438 Patent on the meaning of the term "axial accelerations."

109. Second, Dr. LaViola cannot and does not point to any guidance in the '438 Patent as to how to decompose the individual components of the acceleration reported by an accelerometer.

110. Third, Dr. LaViola does not point to any guidance in the '438 Patent on how to convert the axial accelerations into a common state with the angular velocities as he proposes. For example, although Dr. LaViola argues that angular velocities are different quantities than axial accelerations, he does not set forth an exact description of how one or both of these quantities are transformed in order to accomplish the comparison.

111. A POSA would have understood (for the reasons already described), that this is mathematically impossible. Assuming for the sake of argument that the individual acceleration components are separable (which they are not), a conversion into a common state followed by a comparison is still not described or possible.

112. Specifically, if the axial accelerations are interpreted as linear accelerations, converting the linear accelerations into a common state with an angular velocity is mathematically impossible. A linear line is a curved line with an infinite radius and therefore an object moving along it has no angular velocity.

113. If the reported axial accelerations are interpreted as gravitational accelerations, converting the gravitational accelerations into a common state with the angular velocities is also impossible. Gravitational accelerations and angular velocities measure fundamentally different independent physical effects that are experienced by a body in motion (rotation versus gravitational force).

114. Similarly, if the axial accelerations are interpreted as the centrifugal acceleration, even

for the simple case of rigid body motion,[1] converting centrifugal accelerations into a common state with the angular velocities for comparison is impossible without knowing the value of the radius of curvature of the object's motion. Nowhere does the '438 Patent disclose how this would be done.

115. I have analyzed all of the passages in the '438 Patent that Dr. LaViola cites in support of CyWee's proposed construction, and none of them address the above deficiencies.

116. Instead, to circumvent these problems, Dr. LaViola attempts to read the comparison of angular velocities and axial accelerations out of the claim language entirely. Specifically, Dr. LaViola contends that contrary to the plain language of the claim, claim 1 of the '438 Patent recites: (i) updating a previous state using the angular velocities in order to generate a second quaternion; (ii) using the second quaternion to generate predicted axial accelerations; and (iii) comparing the predicted axial accelerations with measured axial accelerations. In this way, Dr. LaViola contends that a POSA would have understood the '438 Patent to disclose an Extended Kalman Filter that updates a current state to create an updated quaternion. LaViola Decl., ¶¶ 21–22. I disagree with Dr. LaViola's conclusion.

117. Dr. LaViola's analysis fails to identify any guidance in the '438 Patent on the precise meaning of the term "axial accelerations." A POSA could not determine the specific scope of any claims that include this term.

118. In addition, the intermediary steps that Dr. LaViola relies on: (i) updating a previous state using angular velocities in order to generate a second quaternion; (ii) using the second quaternion to generate a set of predicted axial accelerations; and (iii) comparing the predicted axial accelerations with measured axial accelerations are simply parts of the recitation of a recursive

[1] A POSA would understand that the motion of 3D pointing devices such as those described in these patents-in-suit—at least in part—result from their control by humans. Humans who manipulate such devices subject them to more than rigid object motion. The implications of this fact are not discussed or resolved in the specification of the '438 Patent.

algorithm. These steps would not have adequately informed a POSA as to the scope of the claim. In fact, not all the tools of elementary algebra are available using quaternions since the operation of multiplication is not commutative using the algebra of quaternions. In contrast, in general algebra, multiplication exhibits the commutative property. For example, A multiplied by B is equal to B multiplied by A in elementary algebra, but this property does not hold for quaternions. The specification of the '438 Patent does not discuss this fact about quaternions or discuss its implications with respect to the utilization of quaternions in the '438 Patent, including in Equations (5) through (11) described in more detail below.

119. Finally, Dr. LaViola cites to Equations 5–11 as supporting the alleged enhanced comparison method of the '438 Patent. Dr. LaViola argues that a POSA would have understood that these equations directly reference the Extended Kalman Filter disclosed in the '438 Patent.

120. I disagree with this analysis. It would not have been clear to a POSA what Equations 5–11 are or that they refer to an Extended Kalman Filter. Further, there is no discussion of the scope of motion classes (*e.g.*, rigid body versus non-rigid body motions) to which Equations 5–11 purportedly apply.

121. Specifically, the '438 Patent does not provide an adequate disclosure of Equations 5–11 that would have informed a POSA what the purpose of the equations are and how they are to be used to accomplish the method of claim 1.

122. The equations use numerous undefined functions and variables.

$$P(x_t \mid x_{t-1}, u_t) = F_x P(x_{t-1} \mid x_{t-1}) F_x^T + F_u P(u_{t-1} \mid u_{t-1}) F_u^T + Q_t$$

123. For example, Equation (6) (reproduced above) uses the variable Q_t, which the '438 Patent describes only as "additional motion noise." '438 Patent, col. 13:56, 65. It is not clear how this value is obtained.

124. In addition, Equation (6) uses the functions $P(x_t | x_{t-1}, u_t)$, $P(x_{t-1} | x_{t-1})$, and $P(u_{t-1} | u_{t-1})$. The function *P* is undefined apart from the variables that are input into the function and a general reference to "state transition probability." The '438 Patent does not describe how the variables are used (or what they are) or how the function is calculated.

$$P(z_t \mid x_t) = H_x P(x_t \mid x_{t-1}) H_x^T + R_t$$

125. Similarly, Equation (9) (reproduced above) uses the variable R_t which the '438 Patent again describes only as "measurement noise." '438 Patent, col. 14:11, 16. The '438 Patent does not describe how its value is obtained.

126. Equation (9) also uses functions $P(z_t | x_t)$ and $P(x_t | x_{t-1})$. Again, the function *P* is undefined apart from the variables that are input into the function. The '438 Patent does not describe how the variables are used (or what they are) or how the function is utilized.

127. Equations 5–11 are also not defined in the '438 Patent in any way that would be clear to a POSA to indicate what they are and what they are meant to calculate.

$$D_t = \{[z_t - h(z(t|t-1))] P(z_t|x_t) [z_t - h(x(t|t-1))]^{-1}\}^{1/2}$$

128. For example, the '438 Patent discloses that Equation (11) (reproduced above) is: "an exemplary method of data association of an exemplary equation[.]" '438 Patent, col. 14:19–20. It would not be clear to a POSA what this meant. This description does not explain what the equation is, what it is meant to calculate, what any of the variables used in the equation are or how to obtain any of their values.

129. The equation itself also uses multiple undefined functions. For example, Equation (11) discloses the undefined functions $z(t | t\text{-}1)$ and $x(t | t\text{-}1)$. The functions z and x are undefined apart from the variables that are input into them. To compound this uncertainty, the

result of these undefined functions in Equation (11) is then used as a variable in other undefined functions $h(z(t|t\text{-}1))$ and $h(x(t|t\text{-}1))$.

130. For at least the above mentioned reasons, it is my opinion that one of ordinary skill in the art would not have understood the meaning of this claim element with reasonable certainty.

Response to February 23, 2018 Declaration of Joseph J. LaViola, Jr.

Rigid versus Non-rigid Bodies

131. In his February 23, 2018 declaration with respect to this term, Dr. LaViola argues that the motions of interest in the purported inventions are restricted to rigid bodies because a POSA would understand that the 3D pointing device is a rigid body. LaViola February 23, 2018 Decl., ¶¶ 25–26.

132. Dr. LaViola's analysis misses the point.

133. The fact that a 3D pointing device can be represented as a single rigid body is immaterial. Instead, what matters are the objects that induce the rotational motion upon the 3D pointing device.

134. Even in a simple case where a 3D pointing device equipped with an accelerometer is attached to a rigid body that is inducing the device's rotational movement (such as a large, moving centrifuge), the acceleration reported by the 3D pointing device's accelerometer is determined by: (i) the rate of rotation the 3D pointing device and the centrifuge; and (ii) the radial distance of the accelerometer from the center of the centrifuge—and not by the physical dimensions of the 3D pointing device.

135. As I set forth in ¶ 98, the objects inducing this movement may comprise multiple rigid or non-rigid bodies and the motion undergone by the 3D pointing device may therefore be complex. In such cases, there may not necessarily be a single radius of rotation and the radiuses of motion may not be constant. The statistical characterizations of these values are non-stationary and

incompatible with filtering and other traditional analysis techniques. Nothing in the ’438 Patent teaches how to deal with these the potentially variable rates of rotation.

136. As I set forth in ¶¶ 80 and 98–99, the ’438 Patent never discusses how to obtain complete information with respect to such complex motions, *i.e.*, how to determine all the different possible rotational motions over the entire time interval with all of their potentially different radial motions (each with a potentially different radius of motion).

137. This information is necessary to relate an instantaneous centrifugal force to a corresponding instantaneous angular velocity.

<u>Comparing “Axial Accelerations” With Angular Velocities</u>

138. In his February 23, 2018 declaration with respect to this term, Dr. LaViola does not appear to dispute the points set forth in my January 26th, 2018 declaration. Instead, Dr. LaViola argues that these points are immaterial because a POSA would understand that the ’438 Patent discloses an Extended Kalman filter.

139. In particular, with respect to the multiple possible interpretations of an axial acceleration, Dr. LaViola states:

> Regarding Dr. Mercer’s first reason, **axial accelerations can have multiple interpretations depending on the 3 type of forces (gravity, linear, centrifugal) that can act on an accelerometer.** However, this is immaterial because the ’438 patent acknowledges this fact and specifically teaches how using sensor fusion (i.e., an extended Kalman filter) to combine the accelerometer and gyroscope information can be used to calculate deviation angles for a 3D pointing device. Thus, any person of ordinary skill in the art would indeed understand the nature of axial accelerations and also understand that the ambiguity is not vital in the context of the ’438 patent.

LaViola February 23, 2018 Decl., ¶ 29 (emphasis added).

> Thus, **the ’438 patent asserts that there are ambiguities with axial accelerations**, there is a need to have an enhanced comparison method to compute deviation angles of a 3D pointing device that can deal with these ambiguities, and that the invention disclosed in the

> ’438 patent presents such an enhanced comparison method (i.e., an extended Kalman filter) minimizing the effects of any **axial acceleration ambiguities.**

Id., ¶ 33 (emphasis added).

140. With respect to the inability to decompose the different acceleration components from an accelerometer, Dr. LaViola states:

> Regarding Dr. Mercer’s second reason, that it would be impossible to correctly decompose a given reading from an accelerometer in order to determine the individual values of each of the components of acceleration induced by one or more forces, the same arguments against Dr. Mercer’s first reason still apply. The ability to correctly decompose a given accelerometer reading is not necessary when using an enhanced comparison method (i.e., sensor fusion using an extended Kalman filter) as defined by the ’438 patent.

Id., ¶ 34.

141. With respect to the inability to compare axial accelerations with angular velocities, Dr. LaViola states:

> Regarding Dr. Mercer’s third reason, his allegation that a person of ordinary skill in the art would have understood that it would be mathematically impossible to compare the angular velocities with the axial accelerations is incorrect in the context of the ’438 patent’s enhanced comparison method. I have already opined above that the ’438 patent does not teach or require that a direct comparison between angular velocity and axial acceleration is used in the patents-in suit. Dr. Mercer focuses on the direct comparison between these two quantities. However, any person of ordinary skill in the art would understand that the term “comparison” in this case refers to the ’438 patent’s enhanced comparison method which, in turn refers to an extended Kalman filter.

Id., ¶ 35.

142. Dr. LaViola then argues that a POSA would understand that this Extended Kalman filter is disclosed in Equations 5–11 of the ’438 Patent. *Id.*, ¶¶ 41–43.

143. As an initial matter, the ’438 Patent does not use the words “Kalman filter” or “Extended Kalman filter” anywhere in the specification or the claims, and Dr. LaViola provides no

authoritative support for his assertion that a POSA would recognize the '438 Patent or Equations 5–11 as disclosing an Extended Kalman filter.

144. In my opinion, a POSA would not recognize that the '438 Patent and Equations 5–11 disclose an Extended Kalman filter. This is true under the definition of a POSA I set forth in ¶¶ 39–41 of this declaration. It is also true even when using Dr. LaViola's definition of a POSA—who Dr. LaViola defines as a person with "at least a Bachelor's Degree in Computer Science, Electrical Engineering, Mechanical Engineering, or Physics or equivalent work experience, along with knowledge of sensors (such as accelerometers, gyroscopes, and magnetometers), and mobile computing technologies." LaViola February 23, 2018 Decl., ¶ 11.

145. I have trained hundreds of students and interacted with hundreds of colleagues and customers with this level of education, experience, and knowledge of sensors. For example, I have worked with high level professionals holding such degrees and having extensive experience with similar sensor sets in the horizontal drilling business. Similarly, several of my prior Ph.D. students have extensive industrial and academic experience in this field and are now Fellows of the IEEE. Based on my than 45 years of personal experience (include my interactions with these individuals), I do not believe a POSA (even under Dr. LaViola's definition) would read the '438 Patent and Equations 5–11 and conclude that the patent teaches an Extended Kalman filter.

146. For example, as I described above in ¶¶ 119–129, these equations use numerous undefined functions and variables that would not have informed a POSA what the purpose of the equations were and how they were to be used.

147. Even taking Dr. LaViola's premise at face value, an Extended Kalman filter would not resolve the fundamental ambiguities I discussed above.

148. A Kalman filter is a tool used to work in an environment with a particular class of "noise." The filter estimates the value of a variable where noise has been introduced. This noise is

generally "white" with not-varying statistical parameters. Further it is assumed to be uncorrelated with the data of interest to be collected. An Extended Kalman filter describes the "non-linear" version of a Kalman filter.

149. As set forth *in Fundamentals of Inertial Navigation, Satellite-based Positioning, and their Intergration* by A. Noureldin (2013), a reference cited by Dr. LaViola:

> Kalman filtering relies on the following assumptions (Maybeck 1979; Minkler and Minkler 1993) . . . .
>
> **2. The system noise w_k and the measurement noise η_k are uncorrelated zero mean white noise processes with known auto covariance functions** . . .

Ex. C at 228 (emphasis added).

150. As described above, an Extended Kalman filter is designed to deal with system and measurement noises which are uncorrelated zero mean white noise processes with known auto covariance functions. An Extended Kalman filter is not designed to partition accelerometer readings into linear, centrifugal and gravitational acceleration components and compare axial accelerations with angular velocities, and neither the '438 Patent nor Dr. LaViola disclose how an Extended Kalman filter would do so.

151. Specifically, Dr. LaViola does not explain how the implementation of an Extended Kalman filter would: (i) allow the accelerometer to measure linear, centrifugal and gravitational accelerations independent of one another; (ii) provide for the mathematical ability to compare linear, centrifugal and gravitational accelerations with angular velocities; or (iii) render each of these problems immaterial.

152. These issues are not the result of random, non-deterministic, and uncorrelated noise that can be removed by an Extended Kalman filter, but rather result from: (i) the physical limitations of the sensors; (ii) the mathematical impossibility of comparing certain acceleration components with angular velocities because these acceleration components measure fundamentally different

values than angular velocities; or (iii) the lack of information (such as the radius(es) of centrifugal acceleration) to perform this comparison.

153. Even putting these issues aside, it is also unclear: (i) what would be novel about the ’438 Patent if Dr. LaViola were correct; or (ii) what the scope of the claims would be. Kalman filters have been known in the art since the 1960s.

154. Similarly, the advantages of Extended Kalman filters were widely recognized by 1966. *See e.g.*, Ex. D at 13.

155. Dr. LaViola provides no explanation for how the ’438 Patent differs from Kalman filters and Extended Kalman filters.

E. **“comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T” (’438 Patent, claims 14 and 19)**

156. This element appears in claims 14 and 19 of the ’438 Patent and their dependents.

157. Claim 14 of the ’438 Patent recites (emphasis added):

> 14. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:
>
> obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T-1;
>
> obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ωx, ωy, ωz gained from the motion sensor signals of the six-axis motion sensor module at a current time T;
>
> obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay',

Az' based on the measured angular velocities ωx, ωy, ωz of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; **comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;**

obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and

calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

158. Claim 19 of the ’438 Patent recites (emphasis added):

19. A method for obtaining a resulting deviation including resultant angles in a spatial pointer reference frame of a three-dimensional (3D) pointing device utilizing a six-axis motion sensor module therein and subject to movements and rotations in dynamic environments in said spatial pointer reference frame, comprising the steps of:

obtaining a previous state of the six-axis motion sensor module; wherein the previous state includes an initial-value set associated with previous angular velocities gained from the motion sensor signals of the six-axis motion sensor module at a previous time T−1;

obtaining a current state of the six-axis motion sensor module by obtaining measured angular velocities ωx, ωy, ωz gained from the motion sensor signals of the six-axis motion sensor module at a current time T;

obtaining a measured state of the six-axis motion sensor module by obtaining measured axial accelerations Ax, Ay, Az gained from the motion sensor signals of the six-axis motion sensor module at the current time T and calculating predicted axial accelerations Ax', Ay', Az' based on the measured angular velocities ωx, ωy, ωz of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz; said current state of the six-axis motion sensor module is a second quaternion with respect to said current time T; **comparing the second quaternion in relation to the measured angular velocities ωx,**

> **ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T;**
>
> obtaining an updated state of the six-axis motion sensor module by comparing the current state with the measured state of the six-axis motion sensor module; and
>
> calculating and converting the updated state of the six axis motion sensor module to said resulting deviation comprising said resultant angles in said spatial pointer reference frame of the 3D pointing device.

159. As set forth above, claims 14 and 19 recite "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T."

160. I have considered the meaning of this claim element in the context of the '438 Patent. In my opinion, a POSA would not have understood the meaning of this element with reasonable certainty for at least four reasons.

161. I address each of these reasons in detail below.

<u>"Axial Acceleration" Ambiguities</u>

162. For the same reasons described above in ¶¶ 70–74, a POSA would have understood that the term "axial accelerations" could have multiple possible interpretations.

<u>Inseparability of Components of the Underlying Accelerations</u>

163. For the same reasons described above in ¶¶ 75–81, a POSA would have understood that it is impossible to decompose the reading from an accelerometer potentially determined by some combination of linear acceleration, rotational acceleration, and gravitational acceleration in order to obtain and utilize the measured axial acceleration.

<u>"Predicted Axial Acceleration" Ambiguities</u>

164. A POSA would have understood that the term "predicted axial accelerations" could have multiple possible interpretations for the same reasons that "axial accelerations" can have multiple possible interpretations. (Described above in ¶¶ 70–74.)

165. Specifically, a POSA would not have known whether "predicted axial accelerations" were a prediction of: (i) linear accelerations; (ii) centrifugal accelerations; (iii) gravitational accelerations; or (iv) some combination of the three.

166. Claims 14 and 19 of the '438 Patent recite that "predicted axial accelerations" are calculated "based on the measured angular velocities ωx, ωy, ωz of the current state of the six-axis motion sensor module without using any derivatives of the measured angular velocities ωx, ωy, ωz."

167. If the predicted axial accelerations are predicted linear accelerations or a predicted gravitational acceleration, the angular velocity of an object taken at any point in time has no relationship to these values, and a POSA would have understood such predictions are mathematically impossible.

168. For example, a gyroscope and an accelerometer can be placed on a wheel. Even if one knows that the wheel is spinning and knows the value of its angular velocity, one still cannot determine or predict the size of the combined linear acceleration and gravitational acceleration.

169. If the predicted axial acceleration is a predicted centrifugal acceleration, the centrifugal acceleration of an object depends, as discussed above, on the radius of the curved path in which it is traveling. This radius in general may not be constant and potentially may be compound due to multiple rotations simultaneously acting on the accelerometer with different radiuses of curvature and different centers of rotation—which may not be stationary.

170. Therefore, even with a measured angular velocity (but unknown centers of rotation each with a different radius of rotation), a POSA would have understood the centrifugal

accelerations could not be predicted. As already discussed above, the '438 Patent does not disclose how to determine the radius of the motion inducing the centrifugal acceleration, and in general, a POSA would not have known how to obtain such a radius.

<u>The Mathematical Comparison of Acceleration Components with Angular Velocities Is Generally Impossible</u>

171. For the reasons described above in ¶¶ 82–101, a POSA would have understood that under any of the practical interpretations of "axial accelerations" or "predicted axial accelerations," it would be mathematically impossible to compare the angular velocities with the axial accelerations and predicted axial accelerations.

172. As stated above in ¶¶ 82–101, a POSA would have understood that this would require the mathematically impossible comparison of: (i) units that measure fundamentally different attributes of an object (*i.e.*, comparing linear or gravitational accelerations with angular velocities); or (ii) units with undefined variables (*i.e.*, comparing a centrifugal acceleration with an undefined radius with angular velocities.).

173. The fact that claims 14 and 19 recite a "second **quaternion** in relation to the measured angular velocities" does not change my analysis.

174. A POSA would have understood that a quaternion is just a mathematical notation. A "quaternion in relation to the measured angular velocities" is therefore a mathematical tool which can be used for calculating and analyzing an object's angular rotation. As described above in ¶ 118, not all the tools of elementary algebra are available using quaternions. The '438 Patent does not discuss this fact or discuss its implications with respect to the utilization of quaternions in the '438 Patent, including in Equations (5) through (11) discussed in more detail below.

175. Accordingly, the fact that this value is in quaternion representation does not remedy the fact that it is: (i) mathematically impossible to compare a quaternion representing the object's angular rotation with its linear acceleration; (ii) mathematically impossible to compare a quaternion

representing the object's angular rotation with its gravitational acceleration; (iii) mathematically impossible to compare a quaternion representing the object's angular rotation with its centrifugal acceleration; and (iv) mathematically impossible to do any of these comparisons while also performing a comparison with the "predicted axial accelerations." This is so unless there is a known constant radius of rotation and a known, constant center of rotation, which is practically impossible. This is particularly true because the patent claims a pointing device, which by its nature may be moved as the user wishes, not with a fixed radius and center of rotation.

Response to January 12, 2018 Declaration of Joseph J. LaViola, Jr.

176. I understand that CyWee alleges that the limitation "comparing the second quaternion in relation to the measured angular velocities ωx, ωy, ωz of the current state at current time T with the measured axial accelerations Ax, Ay, Az and the predicted axial accelerations Ax', Ay', Az' also at current time T" does not require construction.

177. I understand that CyWee alleges in the alternative that if the term is construed, it should be construed as: "utilizing the second quaternion obtained from the measured angular velocities ωx, ωy, ωz of the current state at current time T, the measured axial accelerations Ax, Ay, Az, and the predicted axial accelerations Ax', Ay', Az' also at current time T to obtain an updated state or updated quaternion."

178. In his declaration in support of CyWee's proposed construction, Dr. LaViola contends that the "comparing" limitation is definite because it recites a step in which a second quaternion is computed using angular velocities ωx, ωy, ωz measured from the rotation sensor at current time T and a first quaternion representing orientation at previous time T-1. This is "combined" with measured axial accelerations that originate from the accelerometer at current time T and predicted axial accelerations as part of an "enhanced comparison method" in order to compute a third quaternion. LaViola January 12, 2018 Decl., ¶ 24.

179. I disagree with Dr. LaViola's analysis for multiple reasons.

180. First, Dr. LaViola cannot and does not point to any guidance in the '438 Patent on the meaning of the term "axial accelerations."

181. Second, Dr. LaViola cannot and does not point to any guidance in the '438 Patent as to how to decompose the individual acceleration components whose sum is reported by an accelerometer.

182. Third, Dr. LaViola cannot and does not point to any guidance in the '438 Patent on the meaning of the term "predicted axial accelerations." He also does not point to any method disclosed in the '438 Patent of how to calculate predicted axial accelerations in the case of generalized objective motion.

183. Fourth, Dr. LaViola argues that "comparing" as recited in this limitation, means combining the second quaternion with the measured and predicted axial accelerations in order to obtain an updated state. The only evidence that Dr. LaViola cites for the proposition that "comparing" means combining the second quaternion with the measured and predicted axial accelerations is Equations 5–11. LaViola January 12, 2018 Decl., ¶ 29. As I described above in ¶ 118, not all the tools of elementary algebra are available using quaternions. The '438 Patent does not discuss this fact or discuss its implications with respect to the utilization of quaternions in the '438 Patent, including in Equations 5–11.

184. I disagree with Dr. LaViola's analysis of Equations 5–11 for the same reasons as described above in ¶¶ 119–129. As described above, it would not have been clear to a POSA what Equations 5–11 are or that they somehow reference an Extended Kalman Filter.

185. For at least the above mentioned reasons, it is my opinion that one of ordinary skill in the art would not have understood the meaning of this claim element with reasonable certainty.

Response to February 23, 2018 Declaration of Joseph J. LaViola, Jr.

186. Dr. LaViola's arguments in his February 23, 2018 declaration with respect to this term are substantively identical to those I addressed above with respect to the term "utilizing a comparison to compare the first signal set with the second signal set." I disagree with Dr. LaViola's analysis for the reasons I discussed above in ¶¶ 131–155.

F. "generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set" ('978 Patent, claim 10)

187. This element appears in claim 10 of the '978 Patent and its dependents.

188. Claim 10 of the '978 Patent recites (emphasis added):

> 10. A method for compensating rotations of a 3D pointing device, comprising:
>
> generating an orientation output associated with an orientation of the 3D pointing device associated with three coordinate axes of a global reference frame associated with Earth;
>
> generating a first signal set comprising axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame;
>
> generating a second signal set associated with Earth's magnetism;
>
> **generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set;**
>
> generating a rotation output associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device; and
>
> using the orientation output and the rotation output to generate a transformed output associated with a fixed reference frame associated with a display device, wherein the orientation output and the rotation output is generated by a nine-axis motion sensor module; obtaining one or more resultant deviation including a plurality of deviation angles using a plurality of measured magnetisms Mx, My, Mz and a plurality of predicted magnetism Mx', My' and Mz' for the second signal set.

189. Claim 10 recites that the "first signal set" comprises "axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame."

190. Claim 10 recites that the "second signal set" is "associated with [the] Earth's magnetism."

191. I have considered the meaning of this claim element in the context of the '978 Patent. In my opinion, a POSA would not have understood the meaning of this element with reasonable certainty for multiple reasons.

192. I address each of these reasons in detail below.

<u>"Axial Acceleration" Ambiguities</u>

193. For the same reasons described above in ¶¶ 70–74, a POSA would have understood that the term "axial accelerations" could have multiple possible interpretations.

<u>Inseparability of Components of the Underlying Accelerations</u>

194. For the same reasons described above in ¶¶ 75–81, a POSA would have understood that it is impossible to decompose the reading from an accelerometer potentially determined by some combination of linear acceleration, rotational acceleration, and gravitational acceleration in order to obtain and use the measured axial acceleration.

<u>Mathematically Impossible to Generate an Orientation Output Using Axial Accelerations and Magnetisms Without Being Able to Separate and Utilize Components of Acceleration</u>

195. Third, it would not have been clear to a POSA what would satisfy the limitation "orientation output."

196. The '978 Patent describes "orientation output" as some value that is "associated with the orientation of the 3D pointing device associated with the three coordinate axes of the global reference frame associated with the Earth" and can be in the form of "a rotation matrix, a quaternion, a rotation vector, or in a form including the three orientation angles yaw, pitch and roll." '978 Patent, col. 33:29–50; 33:53–64.

197. Claim 10 requires generating the "orientation output" based on either: (i) the "first signal set" comprising "axial accelerations associated with movements and rotations of the 3D pointing device in the spatial reference frame" and the "second signal set," which is "associated with [the] Earth's magnetism"; or (ii) the first signal set, second signal set, and rotation output "associated with a rotation of the 3D pointing device associated with three coordinate axes of a spatial reference frame associated with the 3D pointing device."

198. The '978 Patent does not disclose how to generate this orientation output.

199. A POSA would have understood that it is only mathematically possible to generate an orientation output based on "axial accelerations" and magnetism readings if the axial accelerations are interpreted to be based exclusively on the gravitational accelerations.

200. Otherwise, a POSA would have understood that it is mathematically impossible to determine the direction to the center of the Earth.

201. Even assuming however that this is what the '978 Patent discloses, as noted above, it is impossible to decompose the readings from an accelerometer to obtain just the measured gravitational acceleration in order to obtain the direction to the center of the Earth.

<u>Response to January 12, 2018 Declaration of Joseph J. LaViola, Jr.</u>

202. I understand that CyWee alleges that the limitation "generating the orientation output based on the first signal set, the second signal set and the rotation output or based on the first signal set and the second signal set" does not require construction.

203. I understand that CyWee alleges in the alternative that if the term is construed, it should be construed as: "generating the orientation/deviation angle output based on (1) the first signal set (from an accelerometer), the second signal set (from a magnetometer) and the rotation output (from a rotation sensor or gyroscope) or (2) the first signal set (from an accelerometer) and the second signal set (from a magnetometer)."

204. I understand that in his declaration in support of CyWee's proposed construction, Dr. LaViola contends that a POSA would have understood the meaning of this element with reasonable certainty because the '978 Patent states that: (i) the first signal set originates from the accelerometer; (ii) the second signal set originates from a magnetometer; (iii) the rotation output originates from a rotation sensor or gyroscope; and (iv) the orientation output is the angular position of the device. LaViola January 12, 2018 Decl., ¶¶ 52–54.

205. I disagree with Dr. LaViola's analysis for multiple reasons.

206. First, Dr. LaViola cannot and does not point to any guidance in the '978 Patent on the meaning of the term "axial accelerations."

207. Second, Dr. LaViola cannot and does not point to any guidance in the '978 Patent on how to decompose the reading from an accelerometer into individual acceleration components.

208. Third, Dr. LaViola is unable to point to anything in the '978 Patent that discloses how to generate the orientation output using the axial accelerations and magnetism readings (which is mathematically impossible if the axial accelerations include anything other than a gravitational acceleration component) without being able to decompose the accelerometer readings to utilize the gravitational accelerations.

209. For at least the above mentioned reasons, it is my opinion that one of ordinary skill in the art would not have understood the meaning of this claim element with reasonable certainty.

<u>Response to February 23, 2018 Declaration of Joseph J. LaViola, Jr.</u>

210. In his February 23, 2018 declaration with respect to this term, Dr. LaViola refers back to his arguments directed to the "utilizing a comparison" term in the '438 Patent.

211. Specifically, with respect to the ambiguity of the term "axial accelerations", Dr. LaViola refers back to ¶¶ 29–33 of his February 23, 2018 declaration. I addressed Dr. LaViola's analysis in ¶¶ 139 and 142 of this declaration. Specifically, Dr. LaViola appears to argue that a POSA

would understand that the ambiguity of term "axial accelerations" could be solved using an Extended Kalman filter.

212. With respect to the inability to decompose individual acceleration components from an accelerometer, Dr. LaViola refers back to ¶ 34 of his February 23, 2018 declaration. I addressed Dr. LaViola's analysis in ¶¶ 140 and 142 of this declaration. Specifically, Dr. LaViola appears to argue that a POSA would understand that the inability to decompose individual acceleration components from an accelerometer could be solved using an Extended Kalman filter.

213. With respect to the mathematical inability to generate an orientation output based on axial accelerations and magnetism readings without being able to correctly determine the gravitational acceleration, Dr. LaViola states:

> The '978 patent discloses how to calculate orientation using the axial accelerations (roll and pitch) and the magnetometer measurements (yaw) in Equations 26-28. A person of ordinary skill in the art would understand that the axial accelerations would be based on gravitation in Equations 26-28. **Axial accelerations would be based solely on gravitational accelerations when the device is stationary.**

LaViola February 23, 2018 Decl. ¶ 95.

214. I do not disagree that when a device is stationary, the only acceleration that would be read from an accelerometer would be from gravitational force. However, Dr. LaViola does not elaborate on the significance of this fact. Claim 10 of the '978 Patent does not contemplate that an orientation output is generated only when the device is stationary. Instead, Claim 10 states the first signal set which is used to generate the orientation output comprises "axial accelerations **associated with movements and rotations of the 3D pointing** device in the spatial reference frame." '978 Patent, Claim 10 (emphasis added).[2]

[2] In fact, the plain language of the claim does not even recite gravitational accelerations.

215. Instead, in addressing circumstances where the 3D pointing device is moving, Dr. LaViola states in a conclusory fashion that a POSA would recognize that the ’978 Patent is designed to handle noises and errors that would emanate from moving the 3D pointing device. LaViola February 23, 2018 Decl., ¶¶ 95–96.

216. I disagree with Dr. LaViola’s analysis for the reasons I discussed above in ¶¶ 131–155. Specifically, while I agree that any one of many types of filters, including an Extended Kalman filter—which is never recited in the ’978 Patent and which a POSA would not recognize is disclosed in Equations 5–11 of either the ’438 or ’978 Patents—is designed to handle noise, the axial acceleration components due to linear acceleration and rotational acceleration are not noise.

217. In support of his argument, Dr. LaViola offers a single passage from the ’978 Patent which states simply that the computing processor “may utilize a comparison or algorithm to eliminate accumulated errors of the first, second and/or third signal sets of the nine-axis motion sensor module 302[.]” LaViola February 23, 2018 Decl., ¶ 97 (citing ’978 Patent, 10:64–11:1).

218. First, this passage does not explain how the ’978 Patent purportedly uses a “comparison or algorithm” to eliminate accumulated errors or noise. It merely states that it does so. Dr. LaViola points to no other portion of the ’978 Patent purportedly disclosing the “comparison” or “algorithm” used.

219. Second, as I discussed above in ¶¶ 150–152, Extended Kalman filters are designed to deal with system and measurement noises. An Extended Kalman filter is not designed to partition accelerometer readings into linear, centrifugal and gravitational acceleration components and neither the ’978 Patent nor Dr. LaViola disclose how an Extended Kalman filter would do so.

220. Similarly, errors are the result of things like sensor drift, which can broadly distort the values returned by sensors.

221. The reduction of sensor noise or errors bears no relationship to the inability to

generate an orientation output based on "axial accelerations" and magnetism readings when the device is moving.

222. As I discussed above in ¶¶ 195–201, this problem relates instead to physical limitations of what a magnetometer can measure and the inability of an accelerometer to separately quantify linear, centrifugal, and gravitational accelerations.

V. CONCLUSION

223. The opinions provided in this declaration are offered only to explain how a person of ordinary skill in the art at the time of the alleged invention would understand the meanings of the claim terms discussed above. I reserve the right to discuss any claim limitations at issue or that become at issue as the case develops, as well as the plain and ordinary meaning of any claim term, based on the intrinsic evidence, extrinsic evidence, and on my experience and knowledge in the subject matter of the claimed invention.

224. For at least the above mentioned reasons, it is my opinion that one of ordinary skill in the art would not have understood the meanings of these claim elements with reasonable certainty.

I declare under penalty of perjury of the laws of the United States that the foregoing is true and correct.

Dated: March 9, 2018

M. Ray Mercer

M. Ray Mercer, Ph.D.

Executed in Dallas, Texas.